Large Eddy Simulation of Primary Breakup Processes in Dual Fuel Internal Combustion Engines Using a Fully Compressible Multicomponent Approach

Yu Jiao*, Steffen J. Schmidt, Nikolaus A. Adams

Chair of Aerodynamics and Fluid Mechanics, School of Engineering and Design, Technische Universität München, Boltzmannstr. 15, Garching bei München 85748, Germany,
yu.jiao@tum.de

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Direct numerical simulations of fully compressible multiphase flows in realistic dual fuel internal combustion engine (DFICE) components under realistic operating conditions require enormous computational resources beyond the scope of current investigations. In order to reduce the computational complexity and computational costs, we come up with a simplified atomizing liquid sheet benchmark case. Our set-up is based on properties of the "SprayA-210675 model" with D=89.4μm of a DFICE. The reduced computational nozzle domain is 5D*0.5D*0.5D and the chamber domain is 15D*2.5D*0.5D in x, y, z direction. At the inlet of the reduced domain, liquid n-Dodecane and a mixture of Nitrogen and Methane form a shear layer, while the environment is initially filled with a gas mixture. Periodic boundary conditions in spanwise directions and a symmetry boundary condition at the bottom surface are prescribed. A viscous wall separates the two flows similar to the "SprayA nozzle" geometry and the corner between viscous wall and gas inlet is similar to the "SprayA nozzle" exit. The initial chamber and ambient pressure is 6MPa. Three computational grids (2.50million, 34.56 million, 67.50 million) are used to simulate the shear layer and to analyse the predicted mixing processes depending on the grid resolution. The mesh resolution is varied between 1.788μm and 0.596μm. Velocity differences between the liquid n-Dodecane and the gas mixture are 400m/s, 200m/s and 50m/s.

We employ a numerical algorithm capable of handling fuel primary break-up and compressibility of all involved phases. An Implicit Large Eddy Simulation approach for compact stencils proposed by Egerer et al. [1] based on [2, 3] is used to model sub-grid structures if the resolution is insufficient for DNS. A diffuse interface method is used, together with a barotropic multi-component fluid model. The time integration is performed by an explicit four-stage Runge-Kutta method.

REFERENCES

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